Enhanced Sea Ice Production in the Ross Sea

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Results of analysis of passive microwave data from November 1978 to the present reveal that the sea ice extent in the Antarctic region has been increasing at the rate of about 1% per decade. The key areas of variability has been the Ross Sea and the Bellingshausen/Amundsen Seas where the trends have been 5%/ decade and -7 %/decade, respectively, but the trend for the combined regions is 1%/decade matching that for the entire Antarctic region.

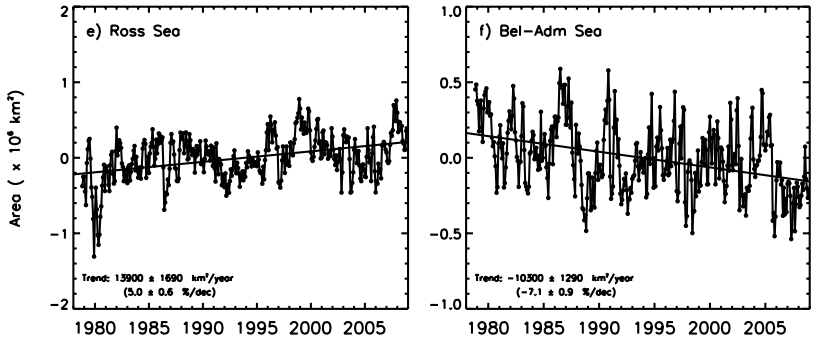

Figure 1: Sea ice extent anomalies in (e) Ross Sea and (f) Bellingshausen/ Amundsen Seas.

Results of analysis of ice drift data in the Ross Sea from 1992 to 2008 show interannual variations consistent with increasing ice fluxes coming out of the coastal polynya regions. The trend in the volume of the net ice exported is approximately equal to ice production in the coastal polynyas. The positive trend in ice extent in the Antarctic could thus be explained by the increase in ice production in the Ross Sea in recent years.

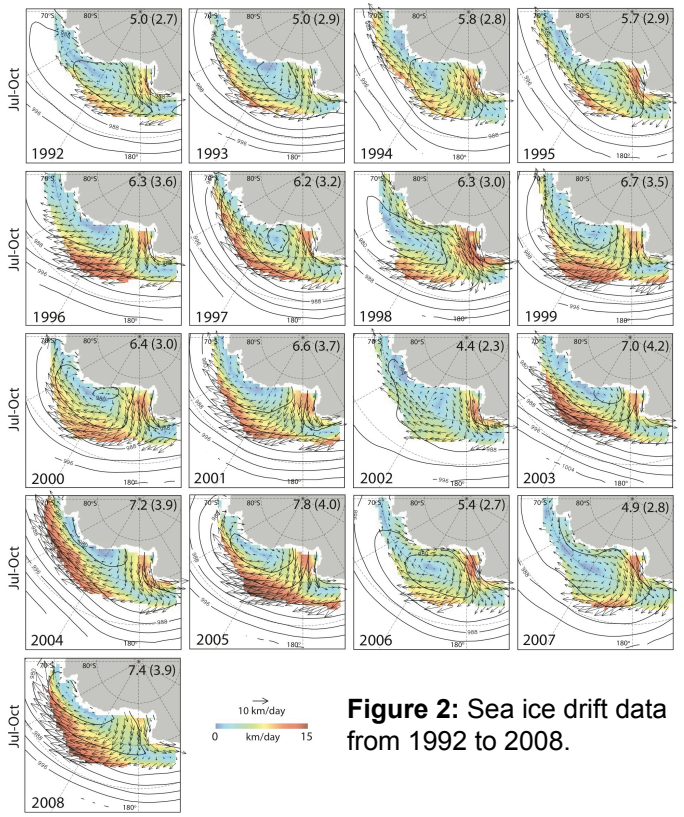

Figure 2: Sea ice drift data from 1992 to 2008.

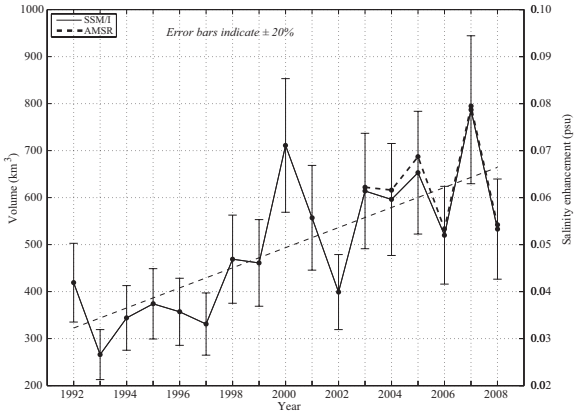

Figure 3: Sea ice production in the Ross Sea shelf.

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References:

Comiso, J. C., R. Kwok, S. Martin, A.L. Gordon (2011), Variability and trends in sea ice extent and ice production in the Ross Sea, *J. Geophys. Res., 116*, C04021, doi:10.1029/2010JC006391.
Turner, J., J.C. Comiso, G. J. Marshall, W.M. Connolley, T.A. Lachlan-Cope, T. Bracegirdle, Z. Wang, M. Meredith and T. Maksym (2009) Antarctic sea ice extent increases as a result of anthropogenic activity, *Geophy. Res. Lett.* **36**, L08502, doi:10.1029/2009GL037524.
Steig, E.J., D.P. Schneider, S.D. Rutherford, M.E. Mann, J.C. Comiso and D.T. Shindell (2009) Warming of the Antarctic ice sheet surface since the 1957 International Geophysical Year, *Nature,* **457**, 459-463.

Data Sources: Satellite passive microwave data from Nimbus-7/SMMR, DMSP/SSM/I and Aqua/AMSR-E and NCEP reanalysis data.

Technical Description of Image:
Figure 1. Monthly anomalies of sea ice extents in the Ross Sea and Bellingshausen/Amundsen Seas. Ice extent is defined as the integral sum of the areas covered by sea ice with 15% ice concentration and higher. The large negative trend in the Bellingshausen/Amundsen sea is apparently offset by the positive trend in the Ross Sea where the sea ice cover is more extensive.
Figure 2. Yearly averages of winter ice drift data from 1992 to 2008 as derived from satellite passive microwave data and corresponding sea level pressure during the same period as derived from NCEP reanalysis data.
Figure 3. Yearly sea ice production and salinization from 1992 to 2008 in the Ross Sea shelf region as derived from coastal polynyas in the region. Coastal polynyas are regarded as ice factories and the key source of bottom water in the Antarctic.

Scientific Significance:
Our study shows that the enhanced ice extent in the Antarctic is mainly due of increases in sea ice production in the Ross Sea that more than offset the large decline in the sea ice cover in the Bellingshausen and Amundsen Seas. Analysis of sea ice drift data over the Ross Sea shelf region from 1992 to 2008 yields a positive rate-of-increase in the net ice export of about 30,000 km^2 per year. For a characteristic ice thickness of 0.6 m, this yields a volume transport of about 20 km^3/year, which is almost identical, within error bars, to our estimate of the trend in ice production in coastal polynyas in the Ross Sea shelf region. Corresponding increase in salt release during sea ice formation in the Ross Sea coastal regions, which is also regarded as a primary forcing for the regional generation of Antarctic Bottom Water, is also provided.

Relevance for future science and relationship to Decadal Survey: Satellite passive microwave data have provided decadal variability of the sea ice cover from 1978 to the present. The trends in the sea ice extent, however, have been observed to be negative in the Arctic and positive in the Antarctic. This study shows that the positive trend in the Antarctic has been caused mainly by the increase in ice production in the Ross Sea region. Such increase is consistent with enhanced winds in the region that is in part the result of the Ozone hole (Turner et al., 2009). The negative trend in the Bellingshausen/Amundsen Seas is also consistent with warming in the region (Steig et al., 2009).

Tools to Support the Reuse of Software Assets for the NASA Earth Science Decadal Survey Missions

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A paper titled "Tools to Support the Reuse of Software Assets for the NASA Earth Science Decadal Survey Missions" by Chris A. Mattmann, Robert R. Downs, James J. Marshall, Neal F. Most, and Shahin Samadi was recently published in the March 2011 newsletter of the IEEE Geoscience and Remote Sensing Society.

This article, adapted from an IEEE IGARSS 2010 paper, describes how the use of tools, such as the Reuse Readiness Levels developed by the NASA Earth Science Data Systems Software Reuse Working Group, can improve capabilities for reusing software in new decadal survey class missions, thus realizing the benefits of reuse (e.g., reduce development effort and ensure reliability).

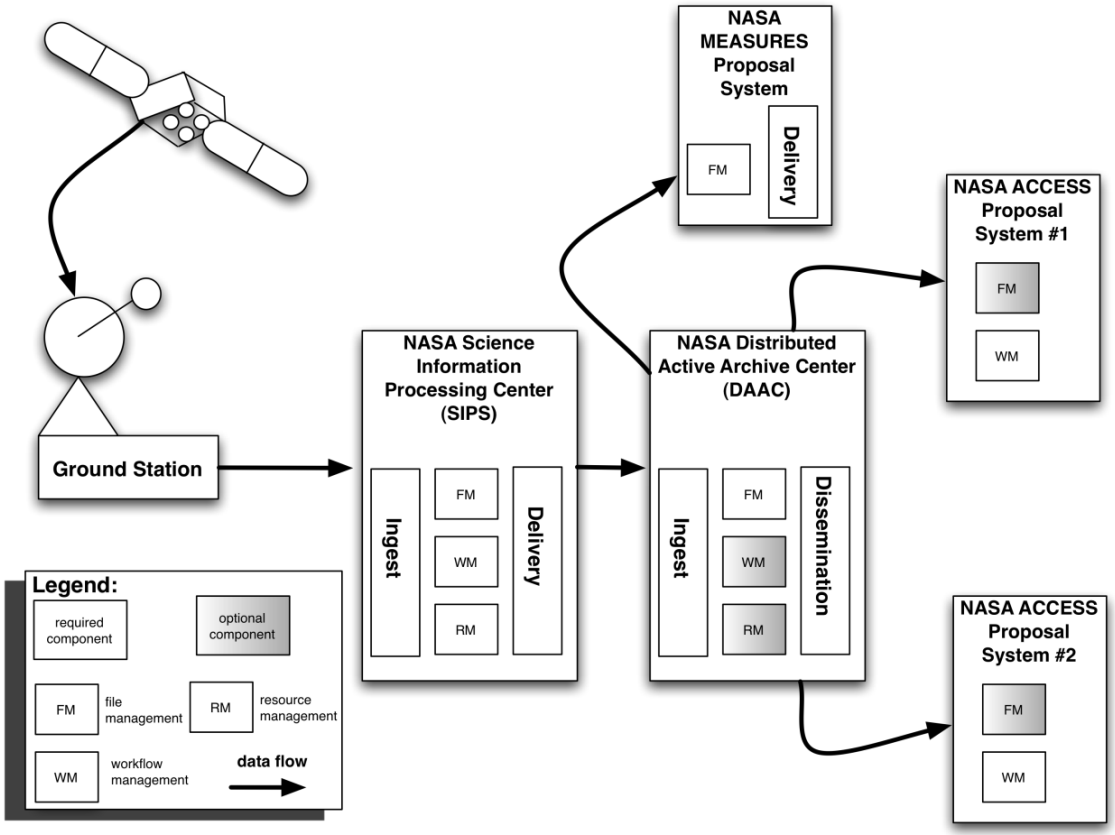

Figure 1: The NASA Earth Science Context

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References:

Mattmann, C.A., Downs, R.R., Marshall, J.J., Most, N.F., Samadi, S. 2011. "Tools to Support the Reuse of Software Assets for the NASA Earth Science Decadal Survey Missions", IEEE Geoscience and Remote Sensing Society Newsletter, March 2011, Issue 158, pp. 17-22. Available: http://www.grss-ieee.org/wp-content/uploads/2011/03/ngrs_NL_0311-Web.pdf

Data sources: Collaborative discussions with members of the NASA ESDS Software Reuse Working Group and their collective experience.

NASA Earth Science Data Systems Software Reuse Working Group. (2010, April 30). Reuse Readiness Levels (RRLs), Version 1.0 [Online] Available: http://www.esdswg.org/softwarereuse/Resources/rrls/

Technical Description of Image:
Figure 1: The NASA Earth Science Context. Data is taken by and sent to ground stations, which move the data to SIPS. DAACs are responsible for long-term archiving of the information, and dissemination. Ad-hoc analyses occur in the ACCESS and MEaSUREs programs. [Mattmann et al., 2011]

Scientific significance: The reuse of existing software assets in the development of new software and systems can save time, money, and effort. For large decadal survey class missions, achieving these benefits can result in significant savings and/or improvements, as evidenced by the experiences of the National Polar-orbiting Operational Environmental Satellite System Preparatory Project's Science Data Segment and the Orbiting Carbon Observatory's Ground Data System [Mattmann et. al, 2011 and references therein].

Relevance for future science and relationship to Decadal Survey: The NASA Earth Science Data Systems Software Reuse Working Group is currently working with the SMAP and ICESat-2 decadal survey missions to help them with their reuse efforts, and plans to offer similar assistance to upcoming decadal survey class missions. Under exploration are ways to use tools such as Reuse Readiness Levels (RRLs) and RRL calculators to assist mission systems developers in their software reuse efforts, making it easier for them to realize the benefits of reuse. The experiences and feedback received from these and other missions can be used to refine and improve reuse tools, thus improving their utility and effectiveness for future missions.